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Jc869 U.S. PTO 09/624522 07/24/00

Case Docket No. PHN 17,569

THE COMMISSIONER OF PATENTS AND TRADEMARKS, Washington, D.C. 20231

Enclosed for filing is the patent application of Inventor:
ROB A. BEUKER

For: MOTION ESTIMATION

***ENCLOSED ARE:***

[X] Appointment of Associates;
[X] Information Disclosure Statement, Form PTO-1449 and copies of documents listed therein;
[ ] Preliminary Amendment;
[X] Specification (10 Pages of Specification, Claims, & Abstract);
[X] Declaration and Power of Attorney:
(1 Page of a [X]fully executed [ ]unsigned Declaration);
[X] Drawing (1 sheet of [ ]informal [X]formal sheets);
[X] Certified copy of EUROPEAN application Serial No. 99202532.0;
[X] Authorization Pursuant to 37 CFR §1.136(a)(3)
[X] Other: RELATED CASES;
[X] Assignment to U.S. PHILIPS CORPORATION.

FEE COMPUTATION

| CLAIMS AS FILED | | | | |
|---|---|---|---|---|
| FOR | NUMBER FILED | NUMBER EXTRA | RATE | BASIC FEE - $690.00 |
| Total Claims | 8 - 20 = | 0 | X $18 = | 0.00 |
| Independent Claims | 2 - 3 = | 0 | X $78 = | 0.00 |
| Multiple Dependent Claims, if any | | | $260 = | 0.00 |
| TOTAL FILING FEE . . . . . . . . . . . . . | | | = | $690.00 |

**Please charge Deposit Account No. 14-1270 in the amount of the total filing fee indicated above, plus any deficiencies. The Commissioner is also hereby authorized to charge any other fees which may be required, except the issue fee, or credit any overpayment to Account No. 14-1270.**

[ ]Amend the specification by inserting before the first line as a centered heading --Cross Reference to Related Applications--; and insert below that as a new paragraph --This is a continuation-in-part of application Serial No. , filed , which is herein incorporated by reference--.

**CERTIFICATE OF EXPRESS MAILING**

Express Mail Mailing Label No. EL458217996US
Date of Deposit July 24, 2000
I hereby certify that this paper and/or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of — Atty. Docket

ROB A. BEUKER — PHN 17,569

SERIAL NO.: — GROUP ART UNIT:

FILED: CONCURRENTLY — EXAMINER:

MOTION ESTIMATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

PRELIMINARY AMENDMENT

Prior to calculating the filing fee and examination, please amend the above-identified application as follows:

IN THE SPECIFICATION

Page 1, before line 1, insert as a centered heading

--BACKGROUND OF THE INVENTION--;

after the heading, insert at the left margin

--Field Of The Invention--;

between lines 4 and 6, insert at the left margin

--Description Of The Related Art--;

lines 11, 13, 20, 21 and 28, after "i.e." insert --,-- (comma);

line 14, after "Therefore" insert --,-- (comma);

line 16, after "e.g." insert --,-- (comma);

line 22, change "candidate the" to --candidate, the--;

line 25, change "WO-A-97/46,022" to --International Patent Application No. WO-A-97/46,022, corresponding to U.S. Patent Application Serial No. 08/863,700, filed May 27, 1997,--;

Page 2, line 1, after "e.g." insert --,-- (comma);

line 3, change "EP-A-0,652,678" to --European Patent Application EP-A-0,652,678, corresponding to U.S. Patent 5,473,379,--;

between lines 7 and 9, insert as a centered heading --SUMMARY OF THE INVENTION--;

lines 12 and 13, delete in their entirety, and insert --apparatus.--;

line 16, change "vectors is" to --vectors, is--;

line 18, after "vector" insert --,-- (comma);

between lines 22 and 24, insert as a centered heading --BRIEF DESCRIPTION OF THE DRAWING--;

between lines 25 and 27, insert as a centered heading --DESCRIPTION OF THE PREFERRED EMBODIMENTS--;

line 27, after "as" insert --a--;

Page 3, line 2, after "vector" insert --,-- (comma);

after "First" insert --,-- (comma);

line 12, after "count" insert --,-- (comma);

line 13, after "blocks" insert --,-- (comma);

line 14, after "counts" insert --,-- (comma);

Page 4, line 17, after "i.e." insert --,-- (comma);

Page 5, line 23, after "i.e." insert --,-- (comma);

Page 6, lines 13, 25, 31 and 32, after "e.g." insert --,-- (comma);

Page 7, line 8, delete "In";

line 9, delete in its entirety;

line 10, delete "the claim.".

## IN THE ABSTRACT

Page 10, before line 1, delete in its entirety, and insert as a centered heading

--ABSTRACT OF THE DISCLOSURE--.

## IN THE CLAIMS

Please amend the claims as follows:

1. (Amended) A motion vector estimation method, comprising the steps [of]:

carrying out a block-based motion vector estimation process [(BME)] that involves comparing a plurality of candidate vectors to determine block-based motion vectors;

determining at least a most frequently occurring block-based motion vector [(MFMV)];

carrying out a global motion vector estimation process [(GME)] using at least the most frequently occurring block-based motion vector [(MFMV)] to obtain a global motion vector [(GMV)]; and

applying the global motion vector [(GMV)] as a candidate vector to the block-based motion vector estimation process [(BME)].

2. (Amended) [A] The method as claimed in claim 1, wherein the determining step includes:

making a selection among block-based motion vectors having a corresponding motion error below a given motion error threshold.

3. (Amended) [A] The method as claimed in claim 1, wherein the determining step includes:

making a selection among block-based motion vectors estimated for blocks having a difference between maximum and minimum pixel values above a given activity threshold.

4. (Amended) [A] The method as claimed in claim 1, wherein both the most frequently occurring block-based motion vector [(MFMV)] and a second-most frequently occurring block-based motion vector [(SMFMV)] are determined and used in the global motion vector estimation process [(GME)].

5. (Amended) [A] The method as claimed in claim 1, wherein said global motion vector estimation process [(GME)] includes the steps [of]:

comparing, on a block basis, a plurality of candidate vectors, including the most frequently occurring block-based motion vector, [(MFMV)] to obtain best vectors determined per block; and

outputting a most-frequently occurring best vector determined per block as the global motion vector [(GMV)].

6. (Amended) A motion vector estimation device, comprising:

block-based motion vector estimation means [(BME)] for determining block-based motion vectors based on a comparison of a plurality of candidate vectors;

means for determining at least a most frequently occurring block-based motion vector [(MFMV, SMFMV)];

means [(GME)] for carrying out a global motion vector estimation process using at least the most frequently occurring block-based motion vector [(MFMV, SMFMV)] to obtain a global motion vector; and

means for applying the global motion vector [(GMV)] as a candidate vector to the block-based motion vector estimation means [(BME)].

7. (Amended) A motion-compensated picture signal processing apparatus, comprising:

a motion vector estimation device as claimed in claim 6 for generating motion vectors; and

a motion-compensated processor [(MCP)] for processing a picture signal in dependence on the motion vectors.

8. (Amended) A picture display apparatus, comprising:

a motion-compensated picture signal processing apparatus as claimed in claim 7 to obtain a processed picture signal; and

a display device for displaying the processed picture signal.

## REMARKS

The specification has been amended in various places to correct typographical and grammatical errors. The specification has also been amended to add section headings.

The claims have been amended to more clearly define the invention as disclosed in the written description. In particular, the claims have been amended for clarity.

When the Examiner takes this case up for examination, it is respectfully requested that this Preliminary Amendment be taken into consideration.

Respectfully submitted,

by

Edward W. Goodman, Reg. 28,613
Attorney
Tel.: 914-333-9611

Motion estimation.

The invention relates to a method and device for motion estimation, a motion-compensated picture signal processing device comprising such a motion estimation device, and a picture display apparatus comprising such a motion-compensated picture signal processing device.

A prior art motion estimation technique, called "3-D Recursive Search", has been described by Gerard de Haan and Robert Jan Schutten, "Real-time 2-3 pull-down elimination applying motion estimation/compensation in a programmable device", IEEE Transactions on Consumer Electronics, Vol. 44, No. 3, August 1988, pp. 930-938. 3-D Recursive Search falls in the class of pixel- or block-recursive motion estimators. The algorithm is based in the following assumptions: motion does not change much in time, i.e. from frame to frame. The algorithm maintains a motion field and tries to update this field only when necessary. The motion field is usually similar for a relatively large region, i.e. for an object. Therefore the motion vectors in the neighborhood of a location are good candidates for the motion in that location. Video consists of a sequence of frames. Each frame is divided into blocks, e.g. of 16x16 pixels. A motion vector is associated with each block. The motion vector should hold the displacement between the block in the current frame compared to the previous frame. Suppose that we want to update the motion vector of block (x,y) in the current frame. 3-D Recursive Search uses only a limited number of candidate vectors, say five, for the estimation, viz. some vectors from the previous frame, i.e. temporal vectors, some vectors from the current frame, i.e. spatial vectors, and an update of a spatial vector. For each candidate the motion estimation error is calculated. The candidate with the lowest motion estimation error is chosen as the best motion vector for that block. The algorithm uses the normal raster scan order to go through the blocks.

WO-A-97/46,022 discloses a method of estimating motion vectors, in which motion parameters are determined for a given field of a video signal, and motion vectors for a subsequent field of the video signal are determined in dependence upon at least one predetermined motion vector (i.e. a motion vector already estimated for a spatio-temporally neighboring block) and at least one additional motion vector derived from the motion parameters. The motion parameters for the given field may be derived from motion vectors

determined for the given field, e.g. by applying a two-dimensional histogram operation on the motion vectors determined for the given field.

EP-A-0,652,678 discloses a method and apparatus for improving a block-based motion compensation in digital video coding. The location of the search window within a reference frame is defined using the global motion of the frame. In one embodiment, the global motion vector is generated utilizing the motion vector occurring with the most repetition within a plurality of previously stored motion vectors.

It is, inter alia, an object of the invention to provide an improved motion estimation technique. To this end, the invention provides a motion estimation method and device, a motion-compensated picture signal processing apparatus, and a picture display apparatus as defined in the independent claims. Advantageous embodiments are defined in the dependent claims.

In a motion vector estimation method in accordance with a primary aspect of the present invention, a block-based motion vector estimation process that involves comparing a plurality of candidate vectors is carried out to determine block-based motion vectors, at least a most frequently occurring block-based motion vector is determined, a global motion vector estimation process using at least the most frequently occurring block-based motion vector is carried out to obtain a global motion vector, and the global motion vector is applied as a candidate vector to the block-based motion vector estimation process.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

The drawing shows a functional block diagram of an embodiment of a motion-compensated picture display apparatus in accordance with the present invention.

When using 3-D Recursive Search for global motion estimation, we have as main task: how to obtain one motion vector from all the motion vectors? Our approach is based on the following steps:

1. The global motion vector is defined as the most used motion vector in appropriate blocks. We also use the second-most used motion vector. A block is appropriate if the motion estimation error is small enough and the block contains enough detail.
2. Make the motion field smooth by introducing a global motion vector candidate.

In fact, we use two motion estimators, a normal motion estimator that is using the global motion vector and a global motion estimator. First we will describe how we extract a global motion from the motion field. We will describe the properties of each motion estimator in the next sections. Finally, it is described how both motion fields are used to build the global motion estimator.

Why do we need two motion vectors? We use the normal motion estimator to track the changes. From the associated motion field we cannot obtain the correct global motion, but only candidate global motion vectors. We use a global motion estimator, still using the 3-D Recursive Search concept, for selecting the best global motion vector. We cannot solely use this global motion estimator because it is not capable of tracking changes.

The global motion is extracted from the motion field in two steps: count for all "appropriate" blocks the number of times that a motion vector is used, and obtain from these counts the most and second-most used motion vectors.

A block is "appropriate" if the motion estimation error is small enough (average SAD smaller than 30), and the block contains enough activity (activity larger than 50) where the activity per block is defined as: activity = $\max_{(i,j)}(y(i,j)) - \min_{(i,j)}(y(i,j))$. We remove the blocks with a low activity, because the motion estimation is not reliable for blocks without detail. Currently, we use the Sum-of-Absolute-Difference measure (SAD) for the displacement error. Let $y[i,j]$ and $y_{prev}[i,j]$ denote the pixel values of the current frame and previous frame, respectively. The Sum-of-Absolute-Difference measure is calculated by:

$$SAD = \sum_{(i,j)} \left| \, y(i,j) - y_{prev}(i + MV_x, j + MV_y) \, \right|,$$

where $(MV_x, MV_y)$ is the candidate motion vector and the summation is over the block. The SAD is set to "0" if it is smaller than a threshold to remove the influence of fixed pattern noise.

We also use the second-most used motion vector to improve the robustness of the algorithm. We found that sometimes the algorithm will favor the zero-motion vector, whereas there is some camera panning. Supplying the global motion estimator with both vectors solves this situation.

The 3-D Recursive Search estimator uses the following 6 candidates:

1. The most-used global motion vector (which is also used as best global motion vector).
2. The spatial vector of block (x- 1,y- 1) (upper left).

3. The spatial vector of block (x+ 1,y- 1) (upper right).
4. The temporal vector of the current block.
5. The temporal vector of block (x,y+1) (lower).
6. An update of the spatial vector of block (x- 1, y- 1) if x is even and of block (x+1,y-1) if x is odd.

The update is obtained as follows. The update vector is the sum of the spatial vector and a delta vector. The delta vector (dx, dy) is read from a list of 16 possible delta vectors. The list of sixteen possible delta vectors is given in the next table.

| j | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dx | 0 | 0 | 0 | 0 | 4 | -4 | 12 | -12 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | -2 |
| dy | 4 | -4 | 8 | -8 | 0 | 0 | 0 | 0 | 1 | -1 | 0 | 0 | 2 | -2 | 0 | 0 |

The table shows that the maximum update per vector is 12 pixels horizontally and 8 pixels vertically.

How do we select a delta vector? We simply use the next delta vector in the list for the next block and start with delta vector 0. Suppose that element j is used for block (x,y), then we use element j+1 for the next block (i.e. block (x+1,y)) and we use delta element "0" if j+1 equals sixteen.

Each candidate is checked to see whether the resulting address is valid, i.e. points to an area within the frame. If not, the vector is clipped to the nearest valid motion vector.

The next table shows the penalties for each vector type. Penalties are added to block matching errors (SAD) in order to favor certain candidate motion vectors over other candidate motion vectors in order to smoothen the motion field.

| Vector type | Penalty (per block) |
|---|---|
| Global motion vector | 3 |
| Spatial vector | 0 |
| Temporal vector current block | 0 |
| Temporal vector lower block | 8 |
| Update vector | 32 |

The global motion estimator uses the following four candidates:

1. Most-used motion vector obtained by the block-based 3-D Recursive Search estimator.

2. Second-most used motion vector obtained by the block-based 3-D Recursive Search estimator.

3. Cyclically varying updates of the motion vector mentioned at 1 (see above).

4. Cyclically varying updates of the motion vector mentioned at 2 (see above).

On a block basis, the global estimator determines which of the four candidates is the best one. From these best candidates determined on a block basis, the most-frequently occurring one is retained.

The penalties for each type are:

| Vector type | Penalty (per block) |
|---|---|
| Motion vector | 0 or 1 |
| Update of motion vector | 32 |

The penalty for the global motion candidate is 1 if the motion vector is zero and 0 otherwise. This may be simplified to "0" only without losing accuracy.

The full motion estimator in accordance with the present invention uses the following steps per frame:

1. Get the best global motion vector from the global motion estimation GME.

2. Use this vector for the 6-candidate 3-D Recursive Search motion estimation BME.

3. Extract the most used and second-most used global motion vectors from the resulting motion field.

4. Use these motion vectors in the global motion estimation GME, i.e. in the four-candidate motion estimation.

5. The global motion is extracted from the resulting motion field and used in step 1.

To reduce the CPU load of the algorithm, the number of motion estimation blocks is reduced by sub-sampling. Since we only require one motion vector per frame, the global motion vector, we do not need to calculate a motion vector for each block, so that the number of used blocks can be sub-sampled. We currently use a sub-sampling factor of two

horizontally and two vertically. Note that we may be able to use a factor of four for the global motion estimation, if necessary. The sub-sampling factor is limited for the following reasons: A too high sub-sampling factor reduces the probability that there are "appropriate candidates" (blocks with a small motion estimation error and a sufficiently high activity). Moreover, using too few blocks will reduce the smoothness of the motion field. In addition, it is possible to apply sub-sampling within a block to reduce the number of pixels.

Using processor-specific features, such as MMX, also helps in speeding up the computation. Also, the time spend in the SAD calculation can in principle be reduced by using cross correlation.

To improve the global motion estimation algorithm, the following measures are possible. Retain not only the most used and second-most used global motion vectors, but also less frequently used motion vectors. Use only the central part of the current frame for motion estimation, e.g. a quarter of the frame. If there is some rotation (with the middle of the frame as center of rotation), the blocks in the outer area of the frame will contain more displacement than the central part. Note that this latter measure will also reduce the computational load.

The drawing shows a functional block diagram of an embodiment of a motion-compensated picture display apparatus in accordance with the present invention. A picture signal is applied to a block-based motion vector estimator BME and to a global motion-vector estimator GME that operate as set out above. The block-based motion vector estimator BME applies a most frequently used motion vector MFMV and a second-most frequently used motion vector SMFMV to the global motion-vector estimator GME. The global motion-vector estimator GME applies a global motion vector GMV as a candidate vector to the block-based motion vector estimator BME. The picture signal is also applied to a motion-compensated processor MCP for carrying out, e.g. a motion-compensated interpolation (say, a 100 Hz conversion) or a motion-compensated stitching of images obtained by a scanner or video camera. The motion-compensated processor is controlled by either block-based motion vectors supplied by the block-based motion vector estimator BME or global motion vectors supplied by the global motion estimator GME. A switch S symbolically indicates this choice. In practice, depending on the application, there is no switch S and the appropriate type of motion vectors is used. Global vectors will e.g. be used for stitching scanned images, while block-based vectors will e.g. be used for 100 Hz conversion. The output of the motion-compensated processor MCP is applied to a display device DD. In other applications of the invention, such

as in a scanner, the output of the motion-compensated processor MCP will be printed on paper.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. Where in the above-described examples only a most-used and a second-most used vector are used, it is an obvious generalization clearly falling within the scope of the claims to use the N most-used vectors. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps other than those listed in a claim. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. The invention can be implemented by means of hardware comprising several distinct elements, and by means of a suitably programmed computer. In the device claim enumerating several means, several of these means can be embodied by one and the same item of hardware. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

CLAIMS:

1. A motion vector estimation method, comprising the steps of:

carrying out a block-based motion vector estimation process (BME) that involves comparing a plurality of candidate vectors to determine block-based motion vectors;

determining at least a most frequently occurring block-based motion vector (MFMV);

carrying out a global motion vector estimation process (GME) using at least the most frequently occurring block-based motion vector (MFMV) to obtain a global motion vector (GMV); and

applying the global motion vector (GMV) as a candidate vector to the block-based motion vector estimation process (BME).

2. A method as claimed in claim 1, wherein the determining step includes making a selection among block-based motion vectors having a corresponding motion error below a given motion error threshold.

3. A method as claimed in claim 1, wherein the determining step includes making a selection among block-based motion vectors estimated for blocks having a difference between maximum and minimum pixel values above a given activity threshold.

4. A method as claimed in claim 1, wherein both the most frequently occurring block-based motion vector (MFMV) and a second-most frequently occurring block-based motion vector (SMFMV) are determined and used in the global motion vector estimation process (GME).

5. A method as claimed in claim 1, wherein said global motion vector estimation process (GME) includes the steps of:

comparing, on a block basis, a plurality of candidate vectors including the most frequently occurring block-based motion vector (MFMV) to obtain best vectors determined per block;

outputting a most-frequently occurring best vector determined per block as the global motion vector (GMV).

6. A motion vector estimation device, comprising:

block-based motion vector estimation means (BME) for determining block-based motion vectors based on a comparison of a plurality of candidate vectors;

means for determining at least a most frequently occurring block-based motion vector (MFMV, SMFMV);

means (GME) for carrying out a global motion vector estimation process using at least the most frequently occurring block-based motion vector (MFMV, SMFMV) to obtain a global motion vector; and

means for applying the global motion vector (GMV) as a candidate vector to the block-based motion vector estimation means (BME).

7. A motion-compensated picture signal processing apparatus, comprising:

a motion vector estimation device as claimed in claim 6 for generating motion vectors; and

a motion-compensated processor (MCP) for processing a picture signal in dependence on the motion vectors.

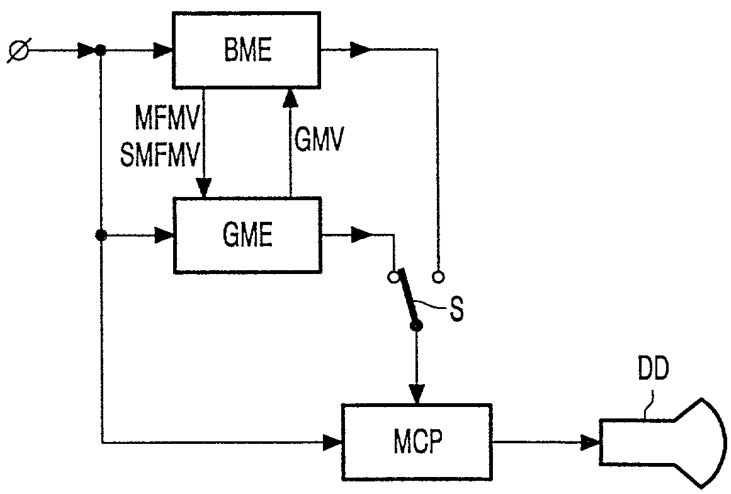
8. A picture display apparatus, comprising:

a motion-compensated picture signal processing apparatus as claimed in claim 7 to obtain a processed picture signal; and

a display device for displaying the processed picture signal.

ABSTRACT:

In a motion vector estimation method, a block-based motion vector estimation process (BME) that involves comparing a plurality of candidate vectors is carried out to determine block-based motion vectors, at least a most frequently occurring block-based motion vector (MFMV) is determined, a global motion vector estimation process (GME) using at least the most frequently occurring block-based motion vector (MFMV) is carried out to obtain a global motion vector (GMV), and the global motion vector (GMV) is applied as a candidate vector to the block-based motion vector estimation process (BME).


Ø
BME
MFMV
SMFMV
GMV
GME
S
DD
MCP

# DECLARATION and POWER OF ATTORNEY

ATTORNEY'S DOCKET NO.:
**PHN 17.569**

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled
**"Motion estimation"**
the specification of which (check one)

[x] is attached hereto.

[ ] was filed on ______________ as Application Serial No. ______________ and was amended on ______________ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by the amendment(s) referred to above.

I acknowledge the duty to disclose information which is material to patentability of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

PRIOR FOREIGN APPLICATION(S)

| COUNTRY | APP. NUMBER | DATE OF FILING (DATE, MONTH, YEAR) | PRIORITY CLAIMED UNDER 35 U.S.C. 119 |
|---|---|---|---|
| **Europe** | **99202532.0** | **02 August 1999** | **YES** |
| | | | |

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35 United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1,56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

PRIOR UNITED STATES APPLICATION(S)

| APPLICATION SERIAL NUMBER | FILING DATE | STATUS (PATENTED, PENDING, ABANDONED) |
|---|---|---|
| | | |
| | | |

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

**POWER OF ATTORNEY:** As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Algy Tamoshunas, Reg. No. 27,677
Jack E. Haken, Reg. No. 26,902

| SEND CORRESPONDENCE TO: Corporate Patent Counsel; | DIRECT TELEPHONE CALLS TO: |
|---|---|
| U.S. Philips Corporation; 580 white Plains Road; | (name and telephone No.) |
| Tarrytown, NY 10591 | (914) 332-0222 |

| Dated: June 28, 2000 | | Inventor's Signature: | | |
|---|---|---|---|---|
| Full Name of in Inventor | Last Name **BEUKER** | First Name **Rob** | Middle Name **A.** | |
| Residence & Citizenship | City **Eindhoven** | State of Foreign Country **The Netherlands** | Country of Citizenship **The Netherlands** | |
| Post Office Address | Street **Prof. Holstlaan 6** | City **5656 AA Eindhoven** | State of Country **The Netherlands** | Zip Code |

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of
ROB A. BEUKER

Atty. Docket
PHN 17,569

Serial No.

Group Art Unit:

Filed: CONCURRENTLY

Examiner:

Title: MOTION ESTIMATION

Honorable Commissioner of Patents and Trademarks
Washington, D.C. 20231

APPOINTMENT OF ASSOCIATES

Sir:

The undersigned Attorney of Record hereby revokes all prior appointments (if any) of Associate Attorney(s) or Agent(s) in the above-captioned case and appoints:

**Edward W. Goodman** **(Registration No.28,613) and**
c/o U.S. PHILIPS CORPORATION, Intellectual Property Department,
580 White Plains Road, Tarrytown, New York 10591,
his Associate Attorney(s)/Agent(s) with all the usual powers to prosecute the above-identified application and any division or continuation thereof, to make alterations and amendments therein, and to transact all business in the Patent and Trademark Office connected therewith.

ALL CORRESPONDENCE CONCERNING THIS APPLICATION AND THE LETTERS PATENT WHEN GRANTED SHOULD BE ADDRESSED TO THE UNDERSIGNED
ATTORNEY OF RECORD.

Respectfully,

Algy Tamoshunas, Reg. 27,677
Attorney of Record

Dated at Tarrytown, New York
this 20TH day of July, 2000.

\\SERVER0\SYS2\WPDOCS\GO\MW19GOH0.DS0.doc